Phosphoric acid

Phosphoric acid (also known as orthophosphoric acid or phosphoric (V) acid) is a mineral (inorganic) acid having the chemical formula H₃PO₄. Orthophosphoric acid molecules can combine with themselves to form a variety of compounds which are also referred to as phosphoric acids, but in a more general way. The term phosphoric acid can also refer to a chemical or reagent consisting of phosphoric acids, such as pyrophosphoric acid or triphosphoric acid, but usually orthophosphoric acid.

The conjugate base of phosphoric acid is the dihydrogen phosphate ion, H₂PO₄⁻, which in turn has a conjugate base of hydrogen phosphate, HPO₄²⁻, which has a conjugate base of phosphate, PO₄³⁻.

In addition to being a chemical reagent, phosphoric acid has a wide variety of uses, including as a rust inhibitor, food additive, dental and orthop(a)edic etchant, electrolyte, flux, dispersing agent, industrial etchant, fertilizer feedstock, and component of home cleaning products.

### Specification:

<table>
<thead>
<tr>
<th>Items</th>
<th>Spec</th>
<th>Industry Grade</th>
<th>Food Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>≤</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Assay (as H₃PO₄)</td>
<td>% ≥</td>
<td>85.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Chloride (as Cl⁻)</td>
<td>% ≤</td>
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<td>0.0005</td>
</tr>
<tr>
<td>Sulfates (as SO₄²⁻)</td>
<td>% ≤</td>
<td>0.005</td>
<td>0.003</td>
</tr>
<tr>
<td>Iron (Fe)</td>
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<td>0.001</td>
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<tr>
<td>Arsenic (As)</td>
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<td>0.0001</td>
</tr>
<tr>
<td>Heavy metals, as Pb</td>
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<td>0.001</td>
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<tr>
<td>Oxidable matter (as H₃PO₄)</td>
<td>% ≤</td>
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</tr>
<tr>
<td>Fluoride, as F</td>
<td></td>
<td>0.001</td>
<td></td>
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<tr>
<td>Standard</td>
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<td>GB/T2091-2003</td>
<td>GB3149-92</td>
</tr>
</tbody>
</table>

### Identifiers

- SKU: D9009
- CAS number: 7664-38-2
- HS Code: 2809201900

### Properties

- Molecular formula: H₃PO₄
- Molar mass: 97.995 g/mol
- Appearance: white solid or colorless, viscous liquid (>42 °C)
- Density: 1.885 g/mL (liquid)
  - 1.685 g/mL (85% solution)
  - 2.030 g/mL (crystal at 25 °C)
- Melting point: 42.35 °C (anhydrous)
  - 29.32 °C (hemihydrate)
- Boiling point: 158 °C (decom)
- Solubility in water: 5.48 g/mL
- Acidity (pKa): 2.148, 7.198, 12.319
- Viscosity: 2.4–9.4 cP (85% aq.)
| Protection | Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. |
|---|---|
| Packing and Storage | Packed in 35 kg or 330 kg net plastic drums.

During transportation or storage, the inner cover as well as the outer cover of the packing drums must be well sealed. It is classified as a hazardous product of the 2nd class of risk, and its hazardous chemicals code in China is 93002; It is easily frozen in winter season. |
| Applications | As a reagent

Pure 75–85% aqueous solutions (the most common) are clear, colorless, odorless, non-volatile, rather viscous, syrupy liquids, but still pourable. Phosphoric acid is very commonly used as an aqueous solution of 85% (w/v) phosphoric acid or H₃PO₄.
Because it is a concentrated acid, an 85% solution can be corrosive, although nontoxic when diluted. Because of the high percentage of phosphoric acid in this reagent, at least some of the orthophosphoric acid is condensed into polyphosphoric acids in a temperature-dependent equilibrium, but, for the sake of labeling and simplicity, the 85% represents H₃PO₄ as if it were all orthophosphoric acid. Other percentages are possible too, even above 100%, where the phosphoric acids and water would be in an unspecified equilibrium, but the overall elemental mole content would be considered specified. When aqueous solutions of phosphoric acid and/or phosphate are dilute, they are in or will reach an equilibrium after a while where practically all the phosphoric/phosphate units are in the ortho- form.

Hydrogen halide production

Phosphoric acid reacts with halides to form the corresponding hydrogen halide gas (steamy fumes are observed on warming the reaction mixture). This is a common practice for the laboratory preparation of hydrogen halides.

\[ \text{NaCl(s)} + \ H_3PO_4(l) \rightarrow \text{NaH}_2\text{PO}_4(s) + \text{HCl(g)} \]
\[ \text{NaBr(s)} + \ H_3PO_4(l) \rightarrow \text{NaH}_2\text{PO}_4(s) + \text{HBr(g)} \]
\[ \text{NaI(s)} + \ H_3PO_4(l) \rightarrow \text{NaH}_2\text{PO}_4(s) + \text{HI(g)} \]

Rust removal
Phosphoric acid may be used as a "rust converter", by direct application to rusted iron, steel tools, or surfaces. The phosphoric acid converts reddish-brown iron(III) oxide, Fe2O3 (rust) to black ferric phosphate, FePO4.

"Rust converter" is sometimes a greenish liquid suitable for dipping (in the same sort of acid bath as is used for pickling metal), but it is more often formulated as a gel, commonly called "naval jelly". It is sometimes sold under other names, such as "rust remover" or "rust killer". As a thick gel, it may be applied to sloping, vertical, or even overhead surfaces.

After treatment, the black ferric phosphate coating can be scrubbed off, leaving a fresh metal surface. Multiple applications of phosphoric acid may be required to remove all rust. The black phosphate coating can also be left in place, where it will provide moderate further corrosion resistance (such protection is also provided by the superficially similar Parkerizing and blued electrochemical conversion coating processes).

**Food additive**

Food-grade phosphoric acid (additive E338) is used to acidify foods and beverages such as various colas, but not without controversy regarding its health effects. It provides a tangy or sour taste, and being a mass-produced chemical is available cheaply and in large quantities. The low cost and bulk availability is unlike more expensive seasonings that give comparable flavors, such as citric acid which is obtainable from citrus, but usually fermented by Aspergillus niger mold from scrap molasses, waste starch hydrolysates and phosphoric acid.

**In medicine**

Phosphoric acid is used in dentistry and orthodontics as an etching solution, to clean and roughen the surfaces of teeth where dental appliances or fillings will be placed. Phosphoric acid is also an ingredient in over-the-counter anti-nausea medications that also contain high levels of sugar (glucose and fructose). This acid is also used in many teeth whiteners to eliminate plaque that may be on the teeth before application.

*Data from Wikipedia*